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B7C
Selected US specifications from IPC sub-class
B60C

(54) **Pneumatic tyre**

(57) A pneumatic tyre of which the tread surface has an asymmetrical structure, the diameter C at one side of the tyre, the diameter A of the central portion of the tyre and the diameter B at the other side of the tyre being such that 1.015 A > B > 1.000 A, 0.985 A > C > 0.965 A and A-C > B-A. Moreover, the distances l_o and l_i shown in Fig 1 are approximately equal. In use on a vehicle the side of the tyre of greater diameter is nearer to the centre line of the vehicle.

FIG. 1

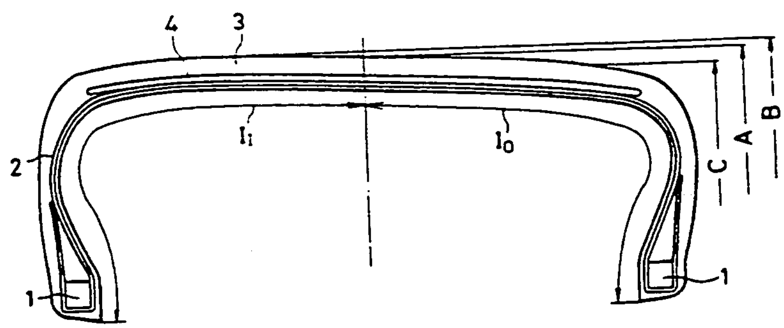

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FIG. 1

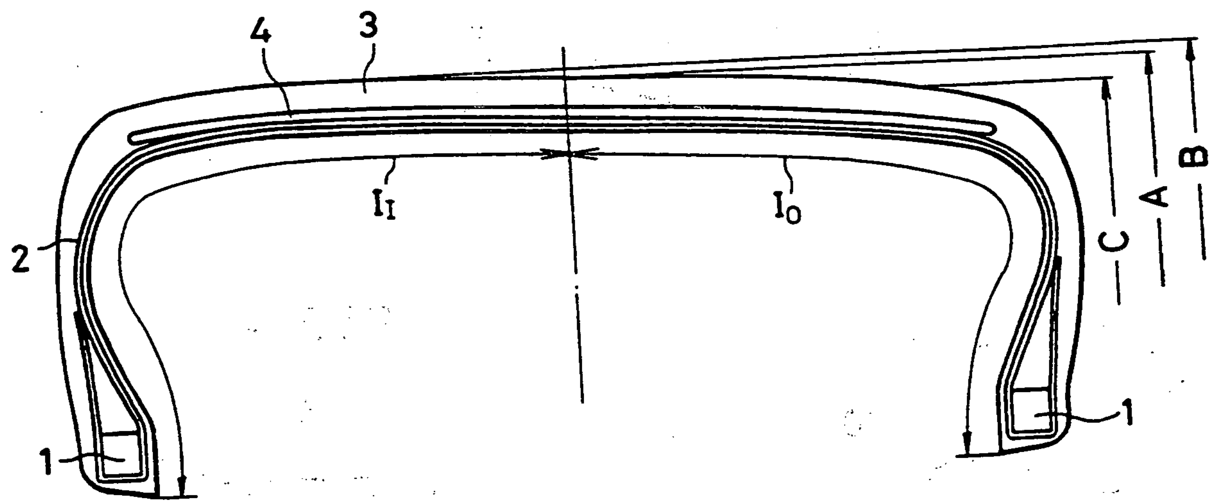


FIG.2

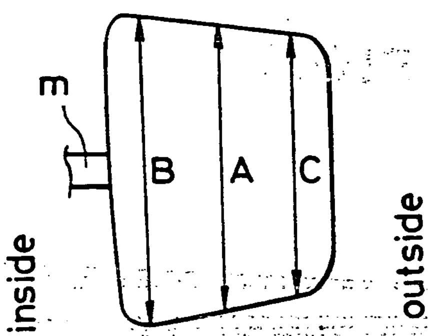


FIG.3

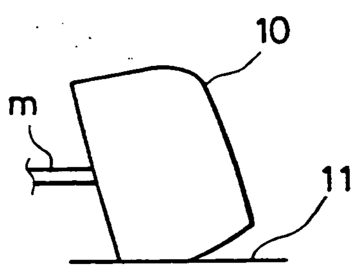


FIG.4

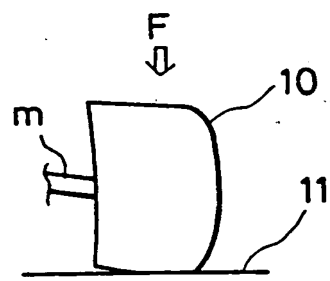


FIG.5

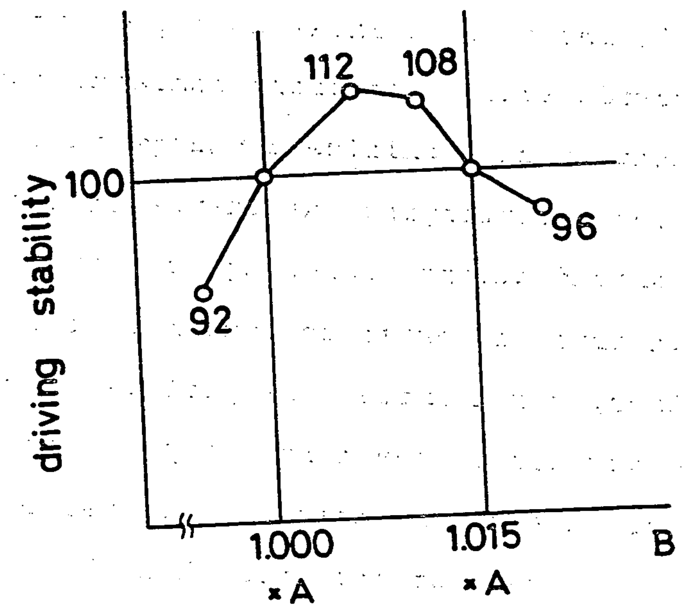
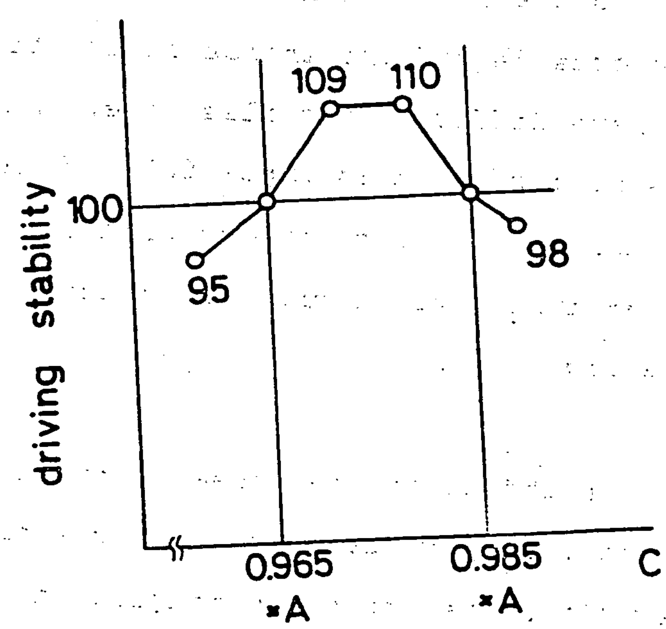

112
108
100
96
92
driving stability
1.000 ×A
1.015 ×A
B

FIG.6


109
110
100
95
98
driving stability
0.965 ×A
0.985 ×A
C

PNEUMATIC TIRE

This invention relates to a pneumatic tire which can provide stable cornering characteristics because it exhibit no significant change in the ground-contacting area accompanying the change in the camber against the ground during cornering at a high speed.

Hitherto, in order to attain stable cornering characteristics, for example, the profile on the surface of the tread portion of the tire was prepared so that the profile on the outside and that on the inside (the outside and the inside of the tire when the tire was mounted on a vehicle) were different from each other (see Japanese Patent Publication No. 52-2162 and Japanese Utility Model Application Kokai Publication No. 55-151603).

However, in the above-described technique in which the outside and the inside of the tire are formed so as to have different profiles (i.e., an asymmetrical profile structure), it is impossible to ensure the grip (road holding properties) during cornering and to attain smooth transient characteristics in the critical state of the cornering.

An object of the present invention is to provide a pneumatic tire capable of attaining stable cornering characteristics even during cornering at a high speed.

Accordingly, the present invention relates to a pneumatic tire characterized in that the tire has, when mounted on a vehicle, an outer diameter, C, of the ground-contacting end portion of the tread surface on the outside of the tire, an outer diameter, A, of the tread surface at the central portion in the widthwise direction of the tire, an outer diameter, B, of the ground-contacting end portion of the tread surface on the inside of the tire, a length of an inner periphery, I_O, from the central portion in the widthwise direction of the tire towards the outside of the tire, and a length of an inner periphery, I_I, from the central portion in the widthwise direction of the tire towards the inside of the tire each satisfying the following relationships and the outer diameter of the tread surface is gradually increased from the outside of the tire towards the inside of the tire:

$$1.015 \times A > B > 1.000 \times A,$$

$$0.985 \times A > C > 0.965 \times A,$$

$$A - C > B - A, \text{ and}$$

$$I_O \doteqdot I_I.$$

The above-described object, other objects and features of the present invention will be apparent from the following description.

Fig. 1 is a meridian cross-sectional view of one form of the pneumatic tire mounted on a vehicle according to the present invention;

Fig. 2 is an illustrative view of the ground-contacting surface of the tire shown in Fig. 1;

Fig. 3 is an illustrative view of the tire of the present invention which is in contact with the road surface during straight travelling;

Fig. 4 is an illustrative view of the tire of the present invention which is in a deformed state during cornering;

Fig. 5 is a graph showing the relationship between the outer diameter A and the outer diameter B and the driving stability during cornering; and

Fig. 6 is a graph showing the relationship between the outer diameter A and the outer diameter C and the driving stability during cornering.

In Fig. 1, the end portions of a carcass layer 2 are bent and turned up around a pair of left and right bead wires 1, 1, respectively, and a belt layer 4 is disposed in a circular form in a tread 3.

In Figs. 1 and 2 each showing a tire mounted on a vehicle, letter A designates an outer diameter of the

tread surface at the central portion in the widthwise direction of the tire, letter B an outer diameter of the ground-contacting end portion of the tread surface on the inside of the tire, letter C an outer diameter of the ground-contacting end portion of the tread surface on the outside of the tire, letter I_O a length of an inner periphery from the central portion in the widthwise direction of the tire towards the outside of the tire, and numeral, I_I, a length of an inner periphery from the central portion in the widthwise direction of the tire towards the inside of the tire. The term "inner periphery" used herein is intended to mean the inner peripheral surface of the tire. In Fig. 2, letter m designates a rotating shaft.

(1) $1.015 \times A > B > 1.000 \times A$

Specifying the relationship between the outer diameter A and the outer diameter B as shown in the above formula brings about a reduction in the value of (B - A), which enables a tire 10 to contact with a road surface 11 while providing a certain degree of the ground-contacting area as shown in Fig. 3, thus ensuring sufficient gripping power with respect to the braking and driving during straight travelling. Further, the ground-contacting area is smaller than that of the conventional

tire having left and right profiles which are symmetrical with each other, which contributes to a reduction in the travel resistance.

When the outer diameter B is 1.015 x A or more, the pressure of the tread surface of the B portion (i.e., the ground-contacting end portion of the tread surface on the inside of the tire) during straight travelling is so high that the tread surface is worn in an early stage but also the braking performance is lowered. Further, as shown in Fig. 5, the driving stability during cornering is also lowered. On the other hand, when the outer diameter B is 1.000 x A or less, the ground-contacting area of the tread surface during cornering is lowered, which brings about a lowering in the driving stability during cornering as shown in Table 5.

The driving stability values shown in Fig. 5 represent results of feeling tests conducted under the following conditions:

Test Car: a front-engine, front-drive (FF) car

Tire Size: 185/50 VR15

Rim Size: 6-1/2JJ x 15

Inflation Pressure: 1.9 kg/cm^2

In connection with each tire, the test car was run by a single driver 15 to 20 rounds on a 4 km 470 m circuit in Fuji Speed Way at a velocity of 1 minute and

42 seconds to 1 minute and 44 seconds per round. The test results are rated by indices taking 100 as the reference value, and greater values than 100 mean more desirable results.

(2) $0.985 \times A > C > 0.965 \times A$

The purpose of specifying the relationship between the outer diameter A and the outer diameter C as shown in the above formula is to minimize the difference in the change in the shape of the ground-contacting portion between the straight travelling and the cornering and particularly to reduce the difference in the change in the ground-contacting area when the side wall portion of the tire is deformed during cornering to increase the chamber against the ground.

As shown in Fig. 6, when the outer diameter C is 0.985 x A or more, the ground-contacting area of the tread surface during cornering is decreased, which causes a lowering in the driving stability during cornering. On the other hand, when the outer diameter C is 0.965 x A or less, the pressure of the tread surface of the B portion during straight travelling is so high that the tread surface is worn in an early stage but also the braking performance is lowered. Further, as shown in Fig. 6, the driving stability during cornering is also lowered.

The driving stability shown in Fig. 6 was evaluated in the same manner as that described with respect to Fig. 5.

(3) A - C > B - A

This relationship was specified in order to minimize the change in the ground-contacting area of the tread surface during cornering. Fig. 4 shows a tire which is in a deformed state during cornering. In Fig. 4, the tire 10 causes little or no deformation even when force F is applied to the tire 10 and therefore causes little or no change in the ground-contacting area of the tread surface relative to the road surface.

(4) $I_O \doteqdot I_I$

The phase difference in the transmission of the input force during cornering between the outside and the inside of the tire can be eliminated by approximating the lengths of the inner peripheries to each other.

(5) The outer diameter of the tread surface is gradually increased from the outside of the tire towards the inside of the tire.

When the outer diameter is not gradually increased but, for example, is stepwise increased, the ground-contacting area of the tread surface during straight travelling is small, which causes a lowering in the braking performance and driving performance during straight travelling.

The present invention will now be described in more detail with reference to the following Example.

Example:

Cornering tests at high speeds (90 to 120 km/hr) were conducted with respect to the tire of the present invention and the conventional tire. The results are shown in Table 1 in terms of an index.

(a) Tire of the present invention:

The tire had a size of 185/50 VR15 and a structure shown in Fig. 1.

A = 580 mm, B = 582 mm, C = 570 mm,

I_O = 143 mm, I_I = 142 mm

$$1.015 \times A = 1.015 \times 580 = 588.7$$

$$1.000 \times A = 1.000 \times 580 = 580$$

$$\therefore$$

$$1.015 \times A > B > 1.000 \times A.$$

$$0.985 \times A = 0.985 \times 580 = 571.3$$

$$0.965 \times A = 0.965 \times 580 = 559.7$$

$$\therefore$$

$$0.985 \times A > C > 0.965 \times A.$$

$$580 - 570 = 10$$

$$582 - 580 = 2$$

$$\therefore$$

$$A - C > B - A$$

$I_O = 143$ mm, $I_I = 142$ mm

$\therefore$

$I_O \fallingdotseq I_I$

(b) Conventional tire:

The tire had a size of 185/50 VR15 and left and right profiles which are symmetrical with each other.

Cornering Test Conditions

Rim Size: 6-1/2J x 15

Inflation Pressure: 1.9 kg/cm^2

Test Car: a 1,600 cc front-engine, front-drive (FF) car of the Group A Specification [according to the racing car classification of marketed cars prescribed by FIA (Federation International Automobile)]

Circuit: a racing circuit in the Fuji Speed Way

Table 1

	tire of the present invention	conventional tire
cornering force	115	100

Note: A greater index means a better performance.

As can be seen from the above Table 1, the tire of the present invention exhibits stable cornering characteristics during travelling at a high speed.

As described above, the present invention enables a tire to exhibit stable cornering characteristics even during cornering at a high speed by virtue of the specifying of the outer diameter of the tire.

CLAIMS

1. A pneumatic tire characterized in that the tire has, when mounted on a vehicle, an outer diameter, C, of the ground-contacting end portion of the tread surface on the outside of the tire, an outer diameter, A, of the tread surface at the central portion in the widthwise direction of the tire, an outer diameter, B, of the ground-contacting end portion of the tread surface on the inside of the tire, a length of an inner periphery, I_O, from the central portion in the widthwise direction of the tire towards the outside of the tire, and a length of an inner periphery, I_I, from the central portion in the widthwise direction of the tire towards the inside of the tire each satisfying the following relationships and the outer diameter of the tread surface is gradually increased from the outside of the tire towards the inside of the tire:

$$1.015 \times A > B > 1.000 \times A,$$

$$0.985 \times A > C > 0.965 \times A,$$

$$A - C > B - A, \text{ and}$$

$$I_O \fallingdotseq I_I.$$

2. A pneumatic tire substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

3. Any novel integer or step, or combination of integers or steps, hereinbefore described and/or as shown in the accompanying drawings, irrespective of whether the present caim is within the scope of, or relates to the same or a different invention from that of, the preceding claims.

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